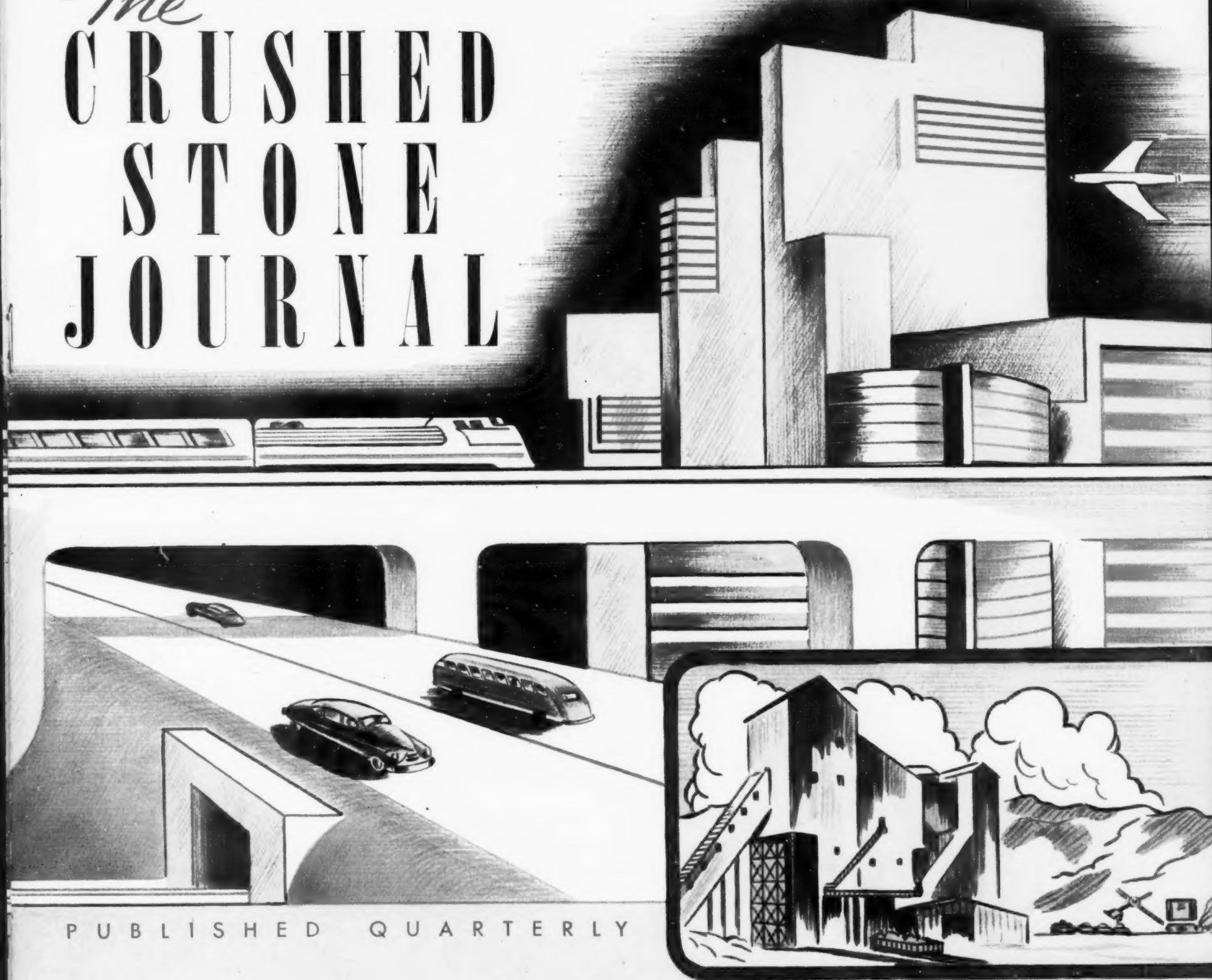
The CRUSHED STONE JOURNAL



PUBLISHED QUARTERLY

March 1952

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OFFICIAL PUBLICATION · NATIONAL CRUSHED STONE ASSOCIATION

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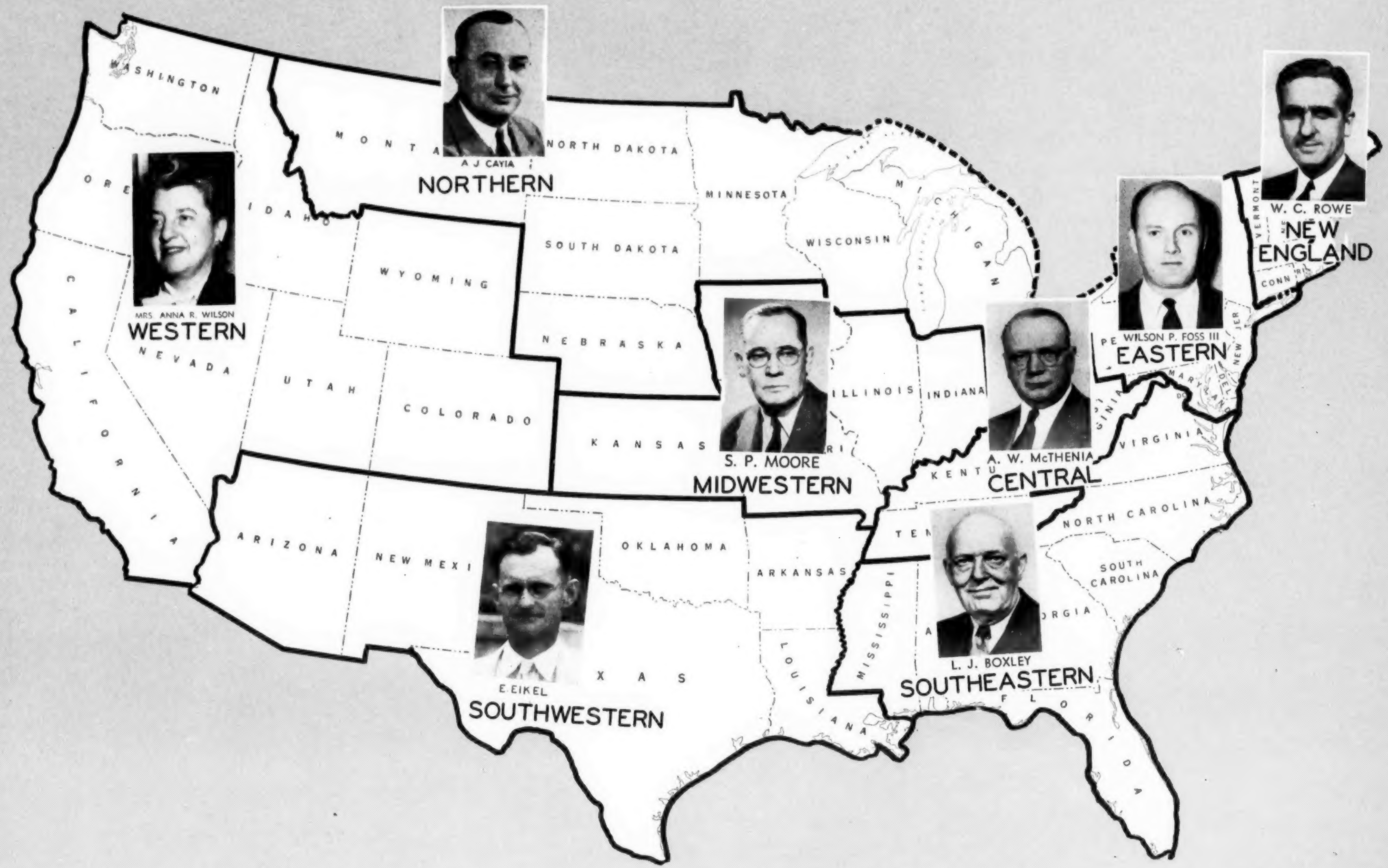
NATIONAL CRUSHED STONE ASSOCIATION



The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

NATIONAL CRUSHED STONE ASSOCIATION

1415 Elliot Place, N. W.
Washington 7, D. C.

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H. C. KRAUSE

President
Columbia Quarry Company
St. Louis, Mo.

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Elected President
NATIONAL CRUSHED STONE ASSOCIATION
by the Board of Directors
Chicago, Illinois

February 17, 1952

IRWIN F. DEISTER

Vice President
Deister Machine Company
Fort Wayne, Ind.

•

Elected Chairman
MANUFACTURERS DIVISION
at its Annual Meeting
Chicago, Illinois

February 19, 1952

THE CRUSHED STONE JOURNAL

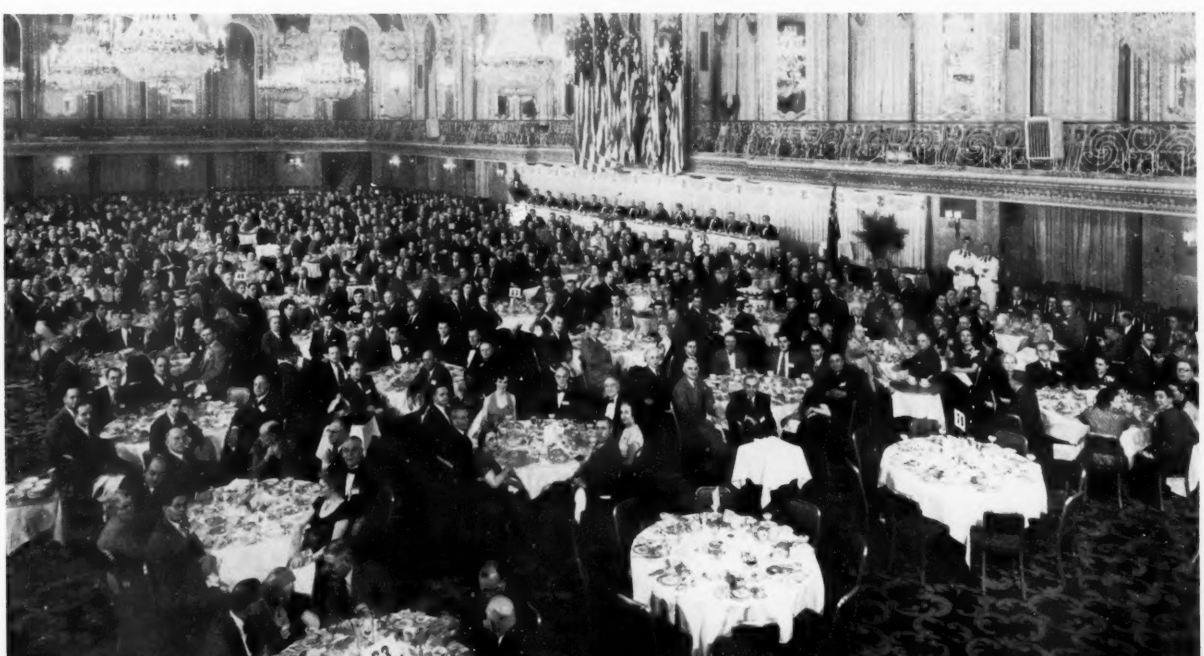
WASHINGTON, D. C.

Vol. XXVII No. 1 PUBLISHED QUARTERLY MARCH 1952

Chicago Attendance Exceeds All Expectations

ON February 18, 19, and 20, 1952, there was held at The Conrad Hilton, Chicago, the best attended Convention and Exposition in the history of the National Crushed Stone Association. Attendance records were shattered when the official registration was determined to be close to 1400, exceeding by nearly 200 the previous high reached in Chicago in 1950.

The Exposition was again an outstanding feature of the Convention and the large numbers attending proved a source of very real gratification to the many exhibitors who participated. Without doubt the Manufacturers Division staged the finest show in its history, and for which it deserves the highest commendation.



Annual Banquet National Crushed Stone Association, Conrad Hilton, Chicago, February 20, 1952

H. C. KRAUSE
Columbia Quarry Co.
St. Louis, Mo.
President
National Crushed Stone Association

J. REID CALLANAN
Callanan Road
Improvement Co.
South Bethlehem,
N. Y.

T. C. COOKE
Lynn Sand and
Stone Co.
Swampscott, Mass.

EXECUTIVE COMMITTEE

of the

NATIONAL CRUSHED STONE ASSOCIATION

for the year 1952

IRWIN F. DEISTER
Deister Machine Co.
Fort Wayne, Ind.
Chairman
Manufacturers
Division

WILSON P. FOSS, III
New York Trap
Rock Corp.
New York, N. Y.

OTHO M. GRAVES
General Crushed
Stone Co.
Easton, Pa.
Honorary Member

S. P. MOORE
Concrete Materials and
Construction Co.
Cedar Rapids, Iowa

RUSSELL RAREY
Marble Cliff Quarries
Co., Columbus, Ohio

W. S. WESTON, JR.
Weston & Brooker Co.
Columbia, S. C.

W. F. WISE
Southwest Stone Co.
Dallas, Texas

NEWLY ELECTED TO NCSA BOARD

O. E. BENSON
General Crushed Stone Co.
Easton, Pa.

H. A. CLARK
Consumers Co.
Chicago, Ill.

ARTHUR GOFF
Wallace Stone Co.
Bay Port, Mich.

NELSON SEVERINGHAUS
Consolidated Quarries Corp.
Decatur, Ga.

The session for operating men and equipment manufacturers attained increased popularity under the somewhat different and we believe improved procedure followed this year. There is a wealth of information to be obtained from a study of the proceedings of this session which we expect to have available for distribution in the near future.

The social side of the Convention proved exceptionally pleasurable, with excellent attendance noted for the Buffet Dinner and Cocktail Party on Monday, both general luncheons, and the Annual Banquet on Wednesday evening. The special features arranged for the ladies, with Mrs. H. A. Clark as a most gracious hostess, contributed much to their enjoyment of the Convention.

For the outstandingly successful meeting recently concluded in Chicago, a real vote of appreciation is due the Convention Arrangements Committee which did its work so well under the able Chairmanship of Otho M. Graves.

Many of the talks presented before the meeting have real practical value and are of lasting benefit. They will be made available either through the columns of the Journal, in mimeographed form, or will be separately printed.

Meeting of Newly Elected NCSA Board of Directors

In the following there are reviewed very briefly certain events which took place at Chicago believed to be of especial interest.

Horace Krause Becomes New President of NCSA

The New Board of Directors, elected by mail ballot prior to the annual convention, held its organizing meeting on Sunday afternoon, February 17, 1952, and proceeded, as provided for in the By-Laws, to elect the President, the Executive Committee, and other officers.

The first order of business was the election of the President and this honor was accorded H. C. Krause, President of the Columbia Quarry Company of St. Louis, Missouri. In becoming President of NCSA, Horace Krause is the first son of a former president to attain this distinction, his father, E. J. Krause, having served in similar capacity in 1921.

On assuming the Chair as President-Elect, Mr. Krause expressed deep appreciation for the honor accorded him and said he would do his best to properly discharge the duties of his high office.

In retiring from the presidency, J. Reid Callanan expressed his sincere and grateful appreciation to the members of the Board for the wholehearted cooperation which had been extended to him throughout his two-year administration.

The Board then proceeded to elect the following seven members, representing the active membership, to serve on the Executive Committee for the ensuing year.

J. Reid Callanan	S. P. Moore
T. C. Cooke	Russell Rarey
Wilson P. Foss, III	W. S. Weston, Jr.
W. F. Wise	

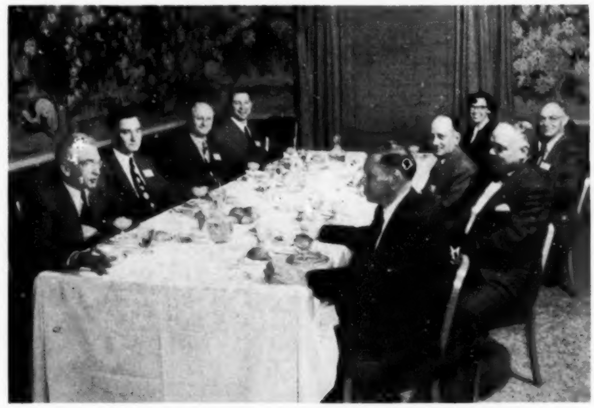
James Savage

Buffalo Crushed Stone Corp., Buffalo, N. Y.

Re-elected Treasurer

Further, the Board elected Otho M. Graves an Honorary Member of the Executive Committee; and F. O. Earnshaw, John Rice, Sr., H. E. Rodes, Stirling Tomkins, and Harold Williams as Honorary Members of the Board of Directors.

In addition, the following officers were unanimously re-elected for the ensuing year: *Treasurer* — James Savage; *Engineering Director* — A. T. Goldbeck; *Administrative Director and Secretary*—J. R. Boyd; *Field Engineer*—J. E. Gray.



Accident Prevention Committee Meeting February 19, 1952

Left—Clockwise around the table:
F. J. Buffington, W. J. Wise, H. F. Yotter, Bruce G. Woolpert, Beatrice G. Gay, J. R. Boyd, C. A. Gustafson, T. W. Jones, E. F. Haberkern.

Representative of British Institute of Quarrying Attends Meeting

Coming as a distinct and most pleasing surprise to those assembled in the opening session of the Convention on Monday morning was the introduction of Myrton Judkins of Judkins Ltd., Nuneaton, England, as the official representative of the British Institute of Quarrying to our 35th Annual Convention. A cordial welcome was extended to Mr. Judkins, who proved an interesting, entertaining, and charming guest. We hope he comes back again soon and assure him that our latch string will always be out.

Awards Made to Safety Contest Winners

An important feature of the General Luncheon on Wednesday, February 20, was the presentation of awards to representatives of the winning plants in the National Crushed Stone Association Safety Contest. The presentations were made by C. A. Gustafson, Chairman of the NCSA Accident Prevention Committee, and in the picture on this page are shown those who were present to receive their awards.

The Accident Prevention Committee met on Tuesday evening to discuss ways of making NCSA's accident reporting program and the Monthly Accident Review of greatest practical value to the membership. The continually increasing interest in safety programs was noted with especial gratification.

Winners in NCSA 1950 Safety Contest

Top row left to right:

Harry Towns, Superintendent, Plant No. 5 Quarry, Eastern Rock Products, Inc., Oriskany Falls, Oneida County, N. Y.

J. P. Cox, Superintendent, Watertown Limestone Quarry, General Crushed Stone Co., Watertown, Jefferson County, N. Y.

C. A. Gustafson, Superintendent, Callanan Road Improvement Co., South Bethlehem, N. Y., *Chairman, NCSA Accident Prevention Committee.*

E. A. Heise, Superintendent, Quarry No. 1, Columbia Quarry Co., Krause, Ill.

W. M. Lunan, Superintendent, Auburn Limestone Quarry, General Crushed Stone Co., Auburn, Cayuga County, N. Y.

Henry Homont, Maintenance Foreman, McCoy Limestone Quarry, Warner Co., Bridgeport, Montgomery County, Pa.

Bottom row left to right:

H. P. Jones, Superintendent, Jordanville Limestone Quarry, General Crushed Stone Co., Jordanville, Herkimer County, N. Y.

Jesse Haney, Superintendent, Plant No. 6 Quarry, Eastern Rock Products, Inc., Prospect, Oneida County, N. Y.

John Kawaske, General Superintendent, Plant No. 1, Callanan Road Improvement Co., South Bethlehem, N. Y.

E. O. Jones, Superintendent, Plant No. 4 Trap Rock Quarry, Southwest Stone Co., Knippa, Uvalde County, Texas.

J. H. McKernan, Superintendent, Middlefield No. 1 Trap Rock Quarry, New Haven Trap Rock Co., Middlefield, New Haven County, Conn.

R. D. Brewer, Superintendent, North Branford No. 7 Trap Rock Quarry, New Haven Trap Rock Co., North Branford, New Haven County, Conn.

IRWIN F. DEISTER
Deister Machine Co.
Fort Wayne, Ind.
Chairman
Manufacturers Division

L. A. EIBEN
Northern Blower Co.
Cleveland, Ohio

EXECUTIVE COMMITTEE

of the

MANUFACTURERS DIVISION

National Crushed Stone Association

for the year 1952

WAYNE W. KING
W. S. Tyler Co.
Cleveland, Ohio

H. C. KRAUSE
Columbia Quarry Co.
St. Louis, Mo.
President
National Crushed Stone Association

B. R. MALONEY
E. I. du Pont
de Nemours & Co.
New York, N. Y.

J. CRAIG MCLANAHAN
McLanahan & Stone
Corp.
Hollidaysburg, Pa.

Manufacturers Division Elects Irwin F. Deister as Chaiman

The Annual Business Meeting and Luncheon of the Manufacturers Division was held during the Convention period on Tuesday, February 19, 1952, with over 200 in attendance.

The report of the Nominating Committee submitted by its able Chairman, Cottrell Farrell, was unanimously adopted and resulted in the election of the following to the offices as designated:

Chairman

Irwin F. Deister, Deister Machine Co., Fort Wayne, Ind.

Vice Chairmen

L. A. Eiben, Northern Blower Co., Cleveland Ohio
Wayne W. King, W. S. Tyler Co., Cleveland, Ohio
B. R. Maloney, E. I. du Pont de Nemours & Co., Inc., New York, N. Y.

Representatives to Serve on NCSA Board of Directors

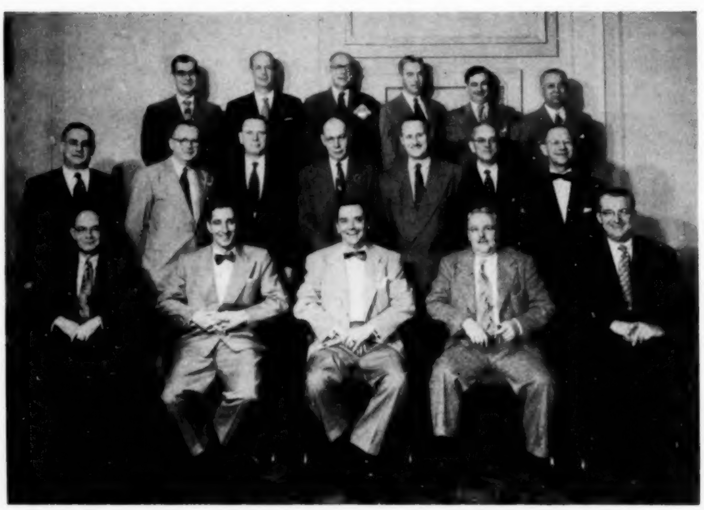
Wayne W. King, W. S. Tyler Co., Cleveland, Ohio
J. Craig McLanahan, McLanahan and Stone Corp., Hollidaysburg, Pa.

Directors

Leonard W. Beck, Cummins Engine Co., Inc., Columbus, Ind.
D. McM. Blackburn, Hendrick Mfg. Co., Carbondale, Pa.
J. B. Bond, Nordberg Mfg. Co., Milwaukee, Wis.
W. E. Collins, Jr., Atlas Powder Co., Wilmington, Del.
C. R. Dodge, Northwest Engineering Co., Chicago, Ill.
R. F. Feind, Allis-Chalmers Mfg. Co., Milwaukee, Wis.
G. P. Fenn, Caterpillar Tractor Co., Peoria, Ill.
H. R. Harrington, Goodyear Tire & Rubber Co., Inc., Akron, Ohio
E. M. Heuston, Bucyrus-Erie Co., South Milwaukee, Wis.
G. C. Holton, American Cyanamid Co., New York, N. Y.
G. W. Hoskins, Harnischfeger Corp., Milwaukee, Wis.
G. H. Keppel, C. G. Buchanan Crushing Machinery Div., Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
R. D. Ketner, General Electric Co., Schenectady, N. Y.
K. F. Lange, Link-Belt Co., Chicago, Ill.
Kenneth Lindsay, Iowa Mfg. Co., Cedar Rapids, Iowa
M. L. McCormack, Ingersoll-Rand Co., New York, N. Y.
H. W. Newton, Barber-Greene Co., Aurora, Ill.
D. J. Phillips, Austin-Western Co., Aurora, Ill.
L. A. Rhodes, Jeffrey Manufacturing Co., Columbus, Ohio
W. A. Rundquist, Pioneer Eng. Works, Inc., Minneapolis, Minn.
A. E. Schneider, Stedman Foundry & Machine Co., Inc., Aurora, Ind.
C. Darrell Smith, Joy Manufacturing Co., Pittsburgh, Pa.
V. L. Snow, Euclid Road Machinery Co., Cleveland, Ohio

It will be recalled that in addition to elected Directors, the Chairman, Vice Chairmen, Representatives on the NCSA Board of Directors, and President of NCSA are ex officio members of the Board of the Manufacturers Division.

Irwin F. Deister, newly elected Chairman of the Manufacturers Division, will serve as an ex officio member representing the Manufacturers Division on the Board of Directors and the Executive Committee of the National Crushed Stone Association.



Present at Get-Together for New Board, Manufacturers Division

Top row left to right:
C. Darrell Smith, Joy Manufacturing Co., Pittsburgh, Pa.
D. J. Phillips, Austin-Western Co., Aurora, Ill.
H. W. Newton, Barber-Greene Co., Aurora, Ill.
V. L. Snow, Euclid Road Machinery Co., Cleveland, Ohio
J. B. Bond, Nordberg Manufacturing Co., Milwaukee, Wis.
L. A. Rhodes, Jeffrey Manufacturing Co., Columbus, Ohio

Middle row left to right:
G. W. Hoskins, Harnischfeger Corp., Milwaukee, Wis.
A. E. Schneider, Stedman Foundry & Machine Co., Inc., Aurora, Ind.
G. P. Fenn, Caterpillar Tractor Co., Peoria, Ill.
G. C. Holton, American Cyanamid Co., New York, N. Y.
W. A. Rundquist, Pioneer Engineering Works, Inc., Minneapolis, Minn.
H. R. Harrington, Goodyear Tire & Rubber Co., Inc., Akron, Ohio
R. F. Feind, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Bottom row, left to right:
J. R. Boyd, National Crushed Stone Association, Washington, D. C., *Secretary*
J. Craig McLanahan, McLanahan and Stone Corp., Hollidaysburg, Pa.
Irwin F. Deister, Deister Machine Co., Fort Wayne, Ind., *Chairman*
Wayne W. King, W. S. Tyler Co., Cleveland, Ohio
L. A. Eiben, Northern Blower Co., Cleveland, Ohio

NEWLY ELECTED TO THE MANUFACTURERS DIVISION BOARD


J. B. Bond
Nordberg Mfg. Co.
Milwaukee, Wis.


G. P. Fenn
Caterpillar Tractor
Co., Peoria, Ill.


H. R. Harrington
Goodyear Tire &
Rubber Co., Inc.
Akron, Ohio


G. W. Hoskins
Harnischfeger Corp.
Milwaukee, Wis.


D. J. Phillips
Austin-Western Co.
Aurora, Ill.


A. E. Schneider
Stedman Foundry &
Machine Co., Inc.
Aurora, Ind.


C. Darrell Smith
Joy Manufacturing
Co., Pittsburgh, Pa.


V. L. Snow
Euclid Road Machinery
Co., Cleveland, Ohio

Manufacturers Division Annual Business Meeting Luncheon, Conrad Hilton, Chicago, February 19, 1952

Some Problems Concerning the Uses of Crushed Stone[1]

By A. T. GOLDBECK

Engineering Director
National Crushed Stone Association
Washington, D. C.

TODAY, instead of reporting on our various activities, I propose rather to discuss a few of the many technical problems which are concerned with the uses of crushed stone.

These problems occur in all of the fields in which stone is used, in highways, in concrete for buildings, in railroad ballast, and in others of lesser importance. They are always interesting, but sometimes troublesome and even baffling. They involve the stone itself, its combination with other materials, and also the design of pavements for carrying traffic. Let's have a glance at some of them, a quick glance but still long enough to gain a passing acquaintance.

Dense Graded Base Courses

First, let us consider the macadam type of pavement. In at least some localities there seems to be a shift away from the old waterbound macadam base course, with its large, uniformly sized stone filled with screenings, in favor of densely graded aggregate construction. Here the stone is specified to a gradation which is intended to produce a dense, uniformly graded, compact layer which will remain stable and which will not become plastic when wet. Gradation is all important to the success of this type.

For the best results the stone must have sufficient fine material of screenings size to fill the voids and it is this fact which some producers have failed to recognize. Ordinary so-called crusher-run stone will not do, for, generally, it is lacking in enough of these desired fines.

Through our Field Engineer, J. E. Gray, we are making a special study of the best way to construct the densely graded aggregate type of base course, and I hope we shall shortly be able to publish information on necessary gradation limitations and on construction methods. However, I shall leave that field to Mr. Gray, who already is able to talk with some authority on this subject. For the future good of our industry I ask you to do all in your power to supply stone which is graded properly for this densely graded aggregate type of construction. You cannot afford failures which a little extra care in production will prevent.

Penetration Macadam Bases

We have a notable example in the New Jersey Turnpike in which the contractors, as a result of their experience elsewhere, elected to use asphaltic penetration macadam in preference to waterbound macadam for base construction under a bituminous concrete surface, because it was considered to be the more economical type. Ability to haul hot mix surfacing material over this penetration macadam base course almost immediately, without thereby disturbing its surface and, likewise, freedom from disturbance of the penetration macadam by other causes, such as heavy rains, were also considerations which led to its selection.

The necessity for adequate use of choke stone and the very thorough compaction of penetration macadam is emphasized. We do not want subsequent excessive compaction of that course under the rolling action of heavy tire loads, for that could cause objectionable, even though shallow, wheel depressions.

Bituminous Concrete

Asphaltic concrete pavements are not new; they have a long record of successful use, and, yet, frequently we encounter troubles and questions concerned with this type of pavement. The question of proper gradation of aggregates still comes before us. What we would all like to see in the finished asphaltic concrete surface is one which will be stable, durable, and non-slippery. We know that stability is controlled largely by proper gradation of aggregate, the use of rough, angular aggregate, not too much asphalt, and not too soft an asphalt. We see asphaltic surfaces which are slippery because they have become so dense under the compacting

[1] Presented at the 35th Annual Convention of the National Crushed Stone Association, Conrad Hilton, Chicago, Illinois, February 18-20, 1952

effect of traffic that there was not sufficient space for the asphalt. There was no place for it to go except to the surface during hot weather and the pavement became slippery.

This is no place to discuss the details of a gradation which will accomplish the desired texture in bituminous concrete, but we seem to have a very simple way of arriving at the optimum gradation for a desirable density and surface texture, no matter what may be the maximum size of stone. I shall be glad to go into details of this method with anyone who may be interested. For highways, we believe in a not too dense, stony textured surface, with asphalt on the lean rather than on the rich side. Too lean a mix can be cured by sealing the surface, but it is difficult to cure an unstable pavement caused by excessive asphalt in the mixture.

The Army, in its runways, seems to want a much denser surfacing than most states desire in their highways. They accomplish this by requiring more fine particles in the aggregate. Their explanation for their very dense surface is that they must support jet planes having high tire pressures and landing at high speeds and the surface must be tough to prevent dislodgment of the aggregate particles. Also, runways are wide and, because of flat grades, water drains off slowly; hence, the surface must be very dense and waterproof. Further, spillage of jet fuel is an important item and an impermeable pavement will at least confine the oil to the surface.

Concrete Pavements

Concrete pavements, like other types, continue to offer technical difficulties which are peculiar to the concrete type. The main problems center around the adequate waterproofing of joints and shoulders. If not waterproofed, water reaches the subgrade, softens it, and then heavy wheel loads cause mud-pumping which, by scour, removes part of the subgrade material from under the slab. Heavy wheel loads then pound and depress the far side of the joint, dowels are bent, and slabs are broken. The slab has "faulted" at the joints.

In the use of screenings and densely graded stone, we have an ideal subgrade treatment under concrete pavements which will do much to prevent scour and mud-pumping of the subgrade, and which will support the concrete properly, thus preventing faulting. Screenings have remarkable load supporting capacity even when subjected directly to wheel loads. This fact has now been recognized by the New Jersey Turnpike engineers, and in the northern section near Newark and New York, screenings have been used, not only for sub-base construction, but also as a surfacing for the shoulders. Even in wet weather a passenger car leaves hardly a mark on the screenings shoulder, so stable is this material. The extreme usefulness of screenings for road construction has not been universally exploited, although its merits are well recognized in certain localities.

As you know, steel for concrete reinforcement and for dowels is in short supply. Dense graded crushed stone or screenings, when used as a sub-base under concrete pavements, will be particularly beneficial under these circumstances. Longitudinal steel does not prevent transverse cracking, but it does serve to hold transverse cracks together. In the absence of this steel the logical procedure is to recognize the inevitability of transverse cracking and build the plain or unreinforced pavement with contraction joints at frequent intervals, say at twenty feet, so as to confine the opening of the slab to these locations. Then, because of the probable absence of dowels, do not provide any expansion joints except at long intervals and thus the pavement will be kept in a state of longitudinal compression and the roughness of the sides of the contraction joints will provide dowel action to some extent. Then, in addition, if a well compacted, dense, stable crushed stone sub-base has been used, the pavement slab will be adequately supported against the faulting or vertical movement of one side of the joint with respect to the other under the action of traffic. One of the state highway departments has reasoned the matter as I have described it and this same design procedure is applicable all over the country.

The use of a granular sub-base under a concrete pavement will be beneficial, even when steel becomes available. There is no better material than densely graded crushed stone or stone screenings for use in the sub-base under a concrete pavement. It will provide needed support at expansion joints and cracks, and will prevent mud-pumping which is so disastrous to concrete pavements under the action of heavy wheel loads.

Concrete pavements have given us a number of research problems over the past several years. We find some pavements are expanding due to several different causes. Some rather porous aggregates, which may otherwise be sound, still make for excessive concrete expansion as evidenced by so-called D-cracking and by too frequent blow-ups. Water

is at the root of this trouble, as it is with most concrete durability troubles. Apparently if the pores in the stone become filled with water, and these pores are small in size, expansion is caused, possibly due to the inability of the water to escape freely. Water has a thermal coefficient of expansion some six or seven times that of stone[2] and, hence, during rising temperatures the expansion of the water in the completely filled pores will tend to expand the stone and, likewise, the concrete. Also it is possible that the expansion of water to ice in the pores will cause disruption. We are confronted with this problem and the one cure which suggests itself is to do those things which will prevent the stone from becoming completely filled with water.

Preliminary drying of stone which, as quarried, is filled with quarry "sap", together with the use of an effective granular base to prevent capillary water from reaching the pavement from the subgrade, seem to be answers to this difficulty. We cannot change the stone but we can change the conditions which make for high water content in the stone. Perhaps the stone or the mortar can be waterproofed, but that would be expensive.

Then there is still another cause for expansion of concrete which, although first noticed in the West, is now being discovered throughout the United States. That is the chemical reactivity trouble in which portland cement is involved as well as the coarse aggregate. This trouble is still baffling the cement chemists and other experts, but it is known that cements containing a relatively high amount of sodium and potassium oxides—a high alkali content—are bad performers when used with stones having certain particular minerals of which the mineral opal is typical. In the course of time, under conditions in which water is present, the alkalis combine with the opal or other hydrous silicates and form alkali silicates which set up internal pressure in the concrete and cause serious cracking and expansion.

But there are evidences that other chemical reactions also take place, the causes of which are not certain. We can duplicate these expansions in the laboratory. The cure sometimes is to use a cement low in alkali, but even this is not always certain. Provided air entrainment is used, still another cure is to replace some 30 to 35 per cent of the portland cement, by solid volume, with a so-called pozzolanic material such as fly ash, which seems to prevent excessive expansion due to alkali reaction. Without air entrainment this pozzolanic cement concrete lacks resistance to freezing.

The cement is undoubtedly a necessary accessory in causing this expansion trouble and some efforts are being made by cement chemists to effect a cure by adding certain chemical compounds to the cement. For illustration, the salts of lithium, experimentally, have been found to be beneficial. One thing is certain—water is the main culprit and if water could be eliminated we would have no chemical action and no chemical expansion. Bridge abutments can and should be waterproofed. Excess water in the soil can be drained away. A granular, low capillary layer of sub-base material can and should be used under concrete pavements for the moisture in the concrete can thus be kept to a very low amount.

The main point for aggregate producers to recognize is that some aggregates do contain minerals which combine with certain chemicals in the cement, notably the alkalis, sodium and potassium, and thus compounds are generated in the concrete which set up internal pressure and thus cause the concrete to grow in volume to a degree which sometimes is harmful. By no means is the aggregate alone at fault, for there is no chemical reactivity until the aggregate is mixed with the cement. The stone producer cannot change the makeup of the stone, but the cement manufacturer can do something to improve his cement. As I see it, the cure for future concrete expansion trouble when due to chemical reactivity lies, to a large extent, with the cement manufacturer. He could use a pozzolanic admixture together with air entrainment; possibly he could add other chemical reactivity preventives or neutralizers.

The engineer can help by proper design of the structure, such as the use of waterproofing and by the requirement of granular, non-capillary layers next to the concrete, and possibly other expedients which will minimize the quantity of moisture absorbed by the concrete. The problem is most difficult and literally hundreds of chemists and engineers in the United States alone are trying hard to solve it, backed by Federal money and with the assistance of well known and highly competent experts in almost all of the governmental departments responsible for the building of durable concrete structures. There surely are solutions other than the rejection of the aggregate.

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[2] Quartz expands 0.0000353 cc per cc per degree C
Water expands 0.000207 cc per cc per degree C

Concrete Proportioning

Just a word regarding concrete proportioning. As you know, the method for proportioning concrete which has gained wide recognition over the past thirty years is based on the water-cement ratio—compressive strength relationship established by D. A. Abrams as a result of tests made at the Lewis Institute in Chicago for the Portland Cement Association. Professor Abrams stated that "with given concrete materials and conditions of test the quantity of mixing water used determines the strength of the concrete so long as the mix is workable." Note the phrase "with given concrete materials." Too many individuals have forgotten, or never knew, that the water-cement ratio law was thus restricted by its originator. The actual fact is that different cements and sands and coarse aggregates will give somewhat different water-cement ratio strength relationships. We in the National Crushed Stone Association knew that many years ago and first called attention to it in our Bulletin No. 3, published in 1927, "The Water Ratio Specification for Concrete and Its Limitations." This water-cement ratio law, when used blindly, will, without just cause, sometimes penalize crushed stone as much as 0.7 of a sack of cement per cubic yard of concrete. We know that penalty is not justified by the facts and to overcome it we have been urging a modification of the method of using the water-cement ratio law. This effort finally culminated in the publication of our Bulletin No. 11 in 1942, "A Method of Proportioning Concrete for Strength, Workability, and Durability," and its revision, to account for air entrainment, in 1949. We have been told by numerous ready mixed concrete producers that they are using Bulletin No. 11 with great success and that they would use no other method. Many colleges and other organizations use it in their concrete courses. It has come rapidly to the front because of its simplicity and because the method it describes really is effective. I urge you to see to it that our Bulletin No. 11 method for proportioning concrete be used. It is safe, easily applied, and its widespread use will overcome the unwarranted cement factor handicap now resulting from the present day method of using the water-cement ratio compressive strength relationship.

While we are on the general subject of concrete, mention should be made of the fire tests recently reported by the National Bureau of Standards. As many of you know, aggregates have been classified in important fire codes depending upon the fire resistant behavior of concrete in which they are used. Typical of these classifications are those of the Joint Committee on Concrete and Reinforced Concrete in which siliceous gravel and quartzite are classified among the aggregates which are not so fire resistant because they cause high expansion of concrete during a fire. National Bureau of Standards publication, Building Materials and Structures Report 124, entitled "Fire Tests of Steel Columns Protected with Siliceous Aggregate Concrete" seems to show test results which are contradictory to previous tests and to actual behavior in disastrous building fires over many years.

I wish simply to warn those of you who are interested in the relative behavior of different aggregates in concrete subjected to intense heat, that you should study these new tests and understand the reasons for the seemingly contradictory results obtained. It may not be possible to find a complete explanation for this anomalous behavior, but I call attention to the relatively small size of the gravel used and especially was the crushed quartz small in size (only 4.9 per cent retained on the No. 4 sieve). Thus the crushed quartz concrete was practically mortar. Siliceous sand is recognized as fire resistant and the crushed quartz as used in these tests probably behaved in a normal manner. The question of dryness of the aggregates is very important in concrete subjected to fire. Small sized aggregate under cover in the laboratory will have little water left in its interior after a few weeks and, undoubtedly its moisture condition is quite unlike that of gravel which is used almost as soon as it is processed in the gravel plant.

Someone is sure to use the Bureau of Standards Report for advertising purposes without much attention to the conditions surrounding these tests or to the differences between them and practical conditions of aggregate production and use. Aggregates in service are frequently saturated when used and such aggregates are by no means as fire resistant as dry aggregates.

Beneficiation of Aggregates

Some of you may be troubled by the presence of an excessive amount of chert in your limestone which causes trouble in concrete. All chert is not detrimental and, fortunately, it is largely the very light, porous chert which is most dangerous. It is that type which takes up a lot of water by absorption and which is lacking in resistance to freezing. The detrimental chert generally has a saturated, bulk

specific gravity of less than 2.40 to 2.45, although somewhat heavier chert also exhibits some lack of durability. However, the elimination of the lighter portions of the chert will effect a very great improvement in the durability of concrete.

The sink-float process, such as used with ores in the mining industry should be given a trial for aggregate beneficiation. It depends primarily on the fact that a heavy liquid having a closely controlled specific gravity can be produced merely by stirring with water a quantity of finely divided heavy solids, such as galena, a lead ore, or ferro-silicon. To those of you troubled with the chert problem, let me say that I believe we can help you through the use of our laboratory facilities.

Tests on Cores

Some of you have been core drilling your stone to discover the location of the acceptable and unacceptable material in your property. Through the use of soundness tests and, in some cases, other physical tests, we have been able to determine where the good and poor stone ledges are located. Some of you may be faced with incomplete acceptance of your quarry, in which case perhaps we could help you to establish some facts that could be of benefit.

Well, these are just a few of many problems, all of them concerned with the use of stone. There are many more just as important; some of them recur, but every year brings new problems to our attention. Our engineering facilities are set up to help our members through research. I assure you we are glad to have you bring your problems to our attention and we shall work on them to the full extent of our capabilities and facilities.

Our industry has every reason to expect prosperity in the future such as it has never known. Our population is growing rapidly and that alone means improved demand for all kinds of materials. Highway traffic is increasing, not only in numbers but also in wheel load intensity, and so great has been the demand for more and safer and more direct highways that toll roads and freeways have had to be provided. Yet we are told that the motor vehicles turned out last year, when placed bumper to bumper, could not be parked on the highways built during that same period. The pent up demand for highways is enormous. Surely the conditions for a continuing prosperity in our industry seem practically certain. Let us hope that neither international forces of evil intent nor our own national economic forces will act to change that picture.

A. T. Goldbeck Elected President of American Concrete Institute

HIS many friends throughout the crushed stone industry will learn with very real pleasure of the election of A. T. Goldbeck, Engineering Director of the National Crushed Stone Association, to the Presidency of the American Concrete Institute, at its 48th Annual Convention in Cincinnati, Ohio, on February 27, 1952.

Mr. Goldbeck has been active in ACI affairs since 1921. He served on the Advisory Committee, 1922-23; Publications Committee, 1944-46; Board of Direction, 1948-51. He is a member of Committee 115, Research; Committee 325, Structural Design of Concrete Pavements for Highways and Airports; Committee 613, Recommended Practice for Proportioning Concrete Mixes; Committee 617, Specifications and Recommended Practice for Concrete Pavements and Bases; and Committee 621, Aggregate Selection, Preparation, Handling and Use. He has been chairman of ASTM Committee C-9 on Concrete and Concrete Aggregates, chairman of the Design Committee of the Highway Research Board and member of two of the Joint Committees on Concrete and Reinforced Concrete.

He joined the staff of the Office of Public Roads in 1910, became assistant engineer in charge of the Philadelphia Municipal Laboratory in 1913, rejoined the reorganized laboratory of the Bureau of Public Roads and Rural Engineering in 1915, and served successively as engineer of tests and chief of the Division of Tests. In these capacities he conducted and directed research in concrete pavement design which included studies of stress distribution under static and moving loads, subgrade pressure measurements, subgrade friction, impact, the flow of concrete, measurements of expansion and contraction.

In January 1951, Mr. Goldbeck received the Distinguished Service Award from the Highway Research Board and in June 1951 he became an Honorary Member of ASTM.

Report on the Construction of Macadam Base Courses of the Non-Bituminous Type[1]

By JOSEPH E. GRAY

Field Engineer
National Crushed Stone Association
Washington, D. C.

JOHN LOUDEN MACADAM was the originator of the idea of building a road surface with relatively small size broken stone instead of using the large hand placed stone roads which were so popular in his day. The term "Macadam" originally was applied to road surfaces of the type which employed the principle of well compacted and interlocked crushed stone whose voids were filled with smaller size stone.

Macadam road construction flourished during the horse and buggy days and, like the horse and buggy, has passed on, because as a road surface it did not hold up under automobile traffic. Nonetheless, the macadam roads that were rehabilitated and given a bituminous surfacing have outlasted all other types of roads. While today macadam construction is relegated to base courses, the fact is that construction of this type does make an excellent foundation for bituminous surfaces.

The original meaning of the word "macadam" as a specific road type has been broadened through popular usage to denote the compacting of a course of broken stone into a solid mass and, therefore, has come to mean a more general type of road construction which includes the commonly called "waterbound macadam base," "rolled rock base," "crusher-run base," and "soil-aggregate base."

Waterbound Macadam Base

In many sections of the country, the highest type roads have been built using waterbound macadam bases, whereas, in other sections waterbound macadam construction has been looked upon with disfavor. It, therefore, appeared desirable to determine what the objections were to this type of construction and how they were being overcome by modern construction practices. The discussion which follows is based upon observations made after visiting several jobs while construction was in progress, and is essentially a report on the construction practices of the several jobs visited. No attempt is made to give a complete answer to any construction problem, but possibly these comments may provoke thought that will lead to mitigating the voiced objections to waterbound macadam as a base course. The objections most frequently heard were:

1. Long delays caused by waiting for subgrade to become dry and firm if adverse weather should occur during construction.
2. Slow rate of building due to large amount of hand labor required.
3. Lack of smoothness of surface causing poor riding qualities in the finished road.
4. Use of huge quantities of large size, closely graded aggregate and screenings and none of the intermediate sizes of stone.

There is no doubt but that the preparation of a proper subgrade is one of the most important features in building a good road of any kind. A firm subgrade, true to grade and cross-section, should be prepared for stone spreading machinery to operate most efficiently. Frequently, this is not done because it is believed that the stone spreader will take care of the irregularities in the subgrade when the first course of stone is placed. While some machines may do a good job in this respect, a better riding surface is assured when the subgrade is finished to accurate grade and cross-section.

It is obviously true that if waterbound macadam is being laid on a clay subgrade and the clay gets wet, it will be slow drying and consequently construction is delayed. However, the widespread practice of putting a drainable sub-base between the subgrade and macadam course overcomes this objection to a large extent. Six to twelve inches of bank-run gravel is used most frequently.

[1] Presented at the 35th Annual Convention of the National Crushed Stone Association, Conrad Hilton, Chicago, Illinois, February 18-20, 1952

Practices vary somewhat as to the width of sub-base laid. On one job the sub-base gravel was placed through the shoulders on fills and trenched in cuts to a width to provide support for an eight-foot shoulder. The bank-run gravel used was readily drainable, stable especially when confined, and was low in cost. Such a sub-base is a desirable feature in the design of a flexible pavement for it aids in distributing the wheel loads over a greater area of the subgrade, thereby reducing the unit pressure, and is particularly advantageous in building waterbound macadam, for it permits the use of relatively large quantities of water for binding without a softening of the subgrade.

Rolled Sub-Base. Observe Tire Imprints of Construction Trucks Indicating Good Stability and Note Modified Bituminous Paver Used for Spreading Stone

Just what constitutes a drainable material has not definitely been established; however, the practice of using bank-run gravel with not more than 5 per cent elutriable material (or not more than 5 per cent passing a 200-mesh sieve) appears to offer a suitable aggregate. The sub-base is brought to grade with the proper crown with as much care as would be used on the highest type of pavement.

The precision that is used in placing this sub-base influences the efficiency of the stone spreading equipment. For instance, with the same type of equipment on an excellently prepared sub-base, one machine operator with two men evening the stone was all that was required to do a first rate job, whereas, on another project where the sub-base was somewhat uneven, three men were on the machine and four to six were trueing up the surface.

Many contractors claim that waterbound macadam construction is slow and often requires a large amount of hand labor. However, these claims need to be considered well before they are accepted as an unalterable fact. In the placing of the stone, some form of stone spreader is universally used. The amount of hand labor required appears to be in proportion to the quality of the equipment and the experience of the contractor.

There are many types of stone spreaders on the market which cover a wide range in price and performance. The lower priced machines are characterized by a short wheel base, or skids, and a fixed strike-off plate, so that any unevenness in the sub-base is reflected in the surface of the stone course. Those spreaders which are pulled by truck have their performance controlled to a large extent by the various truck drivers. Other spreaders which are self-powered and push the truck, but of a short wheel base, have variable performance depending upon the load, for the weight of the truck dumping stone into the hopper of the spreader sometimes forces the front end of the spreader into the sub-base.

Even though stone courses have been laid with any one of these spreaders, the smoothness of the course has been dependent upon the skill of the "stone spotters," men with stone forks leveling the stone, which is a costly, hand labor operation. The long wheel base, self-powered spreaders and modified bituminous pavers, which spread the aggregate through the action of an oscillating screed, do an excellent job of laying the stone to a given elevation, in that the screed can be operated to a string line. The practice is to set a string line to a grade of the loose stone at the center of the road and at the edge, then the screed can place the stone to the grade established by these string lines. Thus the stone can be laid to grade both longitudinally and transversely.

Stone Spreader With Long Wheel Base and Oscillating Screed Does Good Job of Spreading Stone

The work of the stone spotter has been considered very important in obtaining a smooth surface with coarse crushed stone. His job of using a heavy stone fork and removing a little stone from a high spot and filling in a low spot is not only laborious, but

requires considerable skill. Modern labor shuns this type of work, so few with ability are available. Therefore, efficient machines must be used to maintain production with a minimum of hand labor and without loss of quality of work.

Close-up Showing Modified Bituminous Paver Screed Operating to a String Line

After the loose stone is brought to a smooth surface it is rolled, beginning at the shoulders and working toward the center. The purpose of rolling is not only to compact the stone, but also to "key" it; that is, to create aggregate interlock through the angularity of the pieces. Once the stone is keyed so that no further movement occurs, rolling is stopped. If the stone is relatively soft and friable, caution is used so as not to over-roll and break the key by crushing the corners of the stone. Over-rolling is indicated when the stone creeps under the roller.

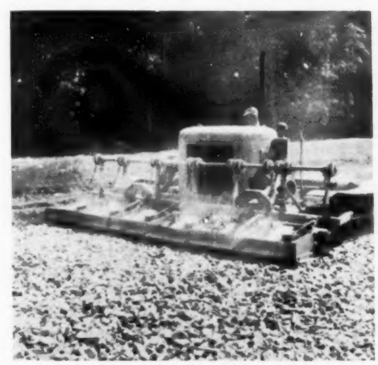
Naturally, no rolling is done when the subgrade is soft or yielding, or when rolling causes a wave-like motion in the surface. Rollers weighing ten tons or more are universally used for this type of work. The heavier rollers often are used on the harder aggregates, such as trap rock. In general, rolling presents no particular problem, but of course, reasonable care should be exercised to avoid the difficulties mentioned above.

A base course to function properly should be stable, not consolidated within itself, and should distribute any load over as large an area of the subgrade as possible. High density is a necessary feature to accomplish this objective. The complete filling of the voids in the rolled stone is, therefore, an essential requirement.

Stone screenings are used most frequently for this purpose; however, where screenings are scarce, sand is used. Filling of the voids is a slow job for many contractors because the screenings not only have to be applied in small increments, but each application has to be hand broomed and rolled. When the voids are filled with dry screenings, the surface is sprinkled with water, which tends to pack the screenings. The procedure for applying screenings—sweeping, rolling, and watering—is continued until a grout forms on the surface, indicating that a dense course has been formed. While vibrating equipment has been developed to work the screenings into the voids in an efficient manner, these machines have not been used as extensively as one would expect, judging from the favorable reports[2] on their performance.

It should be mentioned that the use of an inverted choke or blanket course, consisting of a 1 or 2 in. layer of screenings placed on the base prior to spreading the stone, is effective in preventing the intrusion of the subgrade, in securing density, and in reducing the amount of work required to fill the voids.

What appears to be a contributing cause to the slowness of this operation is a practice of using a graded stone instead of the one size stone used formerly. About 25 years ago, it was the general practice to use 1 1/2 to 2 1/2 in. size stone for trap rock, and to use 2 1/2 to 3 1/2 in. size stone for limestone; whereas, recently a job was being built with stone having a maximum size of 1 1/2 in. with a lower limit of 30 per cent passing the 1 in. sieve.



Vibrating Machine Designed for Filling Voids in Stone With Screenings

The large, one size stone when compacted, has open voids which can be readily filled with screenings without disturbing the stone. In contrast, the graded stone with void spaces of small area are far more difficult to fill. Moreover, there is considerable displacement of the rolled stone under hand brooming. The Simplified Practice Recommendation, sizes 1 and 2, are believed to offer the most desirable grading specifications for waterbound macadam stone. These gradation requirements are as follows:

[2] "Ohio Experiments with Vibration" by Charles W. Allen and S. O. Lingell; *Roads and Streets*, March 1948

Simplified Practice No.	1	2
Nominal Size	1 1/2 to 3 1/2 in.	1 1/2 to 2 1/2 in.
Sieve Size	Total Passing, per cent	
4 in.	100	
3 1/2 in.	90–100	
3 in.		100
2 1/2 in.	25–60	90–100
2 in.		35–70
1 1/2 in.	0–15	0–15
3/4 in.	0–5	0–5

However, one state that has done some waterbound macadam construction throughout the years, while offering an alternate grading, still has a specification for the large, closely sized stone which is as follows:

Sieve Size	Total Passing, per cent
4 in.	100
3 1/2 in.	90–100
3 in.	35–70
2 1/2 in.	0–15

The objection to waterbound macadam base course as the cause of a poor riding bituminous surface is a tacit admission of improper construction. Too much dependence has been placed in the laying of bituminous binder and surfacing courses to take out all irregularities in the base course. Riding qualities are built into a road in the laying of each course. It is close attention to detail in the construction of the base course that gives the riding qualities to the finished road.

On one job, 10 in. steel forms were set carefully to grade for the laying of a 10 in. waterbound macadam base in three courses. While such a procedure would not be advocated because of the cost, the fact remains that a perfect macadam surface was obtained and the final bituminous surface can be described as one that offers a glide ride. On another job, consisting of a heavy duty flexible pavement, two macadam courses, two binder courses, and a surfacing course were each laid to a string line grade as previously described. The allowable variation in smoothness of the final surface was 1/8 in. in 16 ft., which was readily attained by this procedure in placing the materials.

To the stone producer, waterbound macadam construction offers some advantages and disadvantages, depending upon the nature of the business. Quarries that supply metropolitan areas as well as rural areas like the type of business afforded by waterbound macadam because it rounds out their market for all sizes. Usually they have a good demand for concrete stone and black-top stone—the intermediate sizes—and the use of oversize stone and screenings in waterbound macadam consumes their entire production. Therefore, in order to hold their markets for this type of macadam, they should be active in encouraging the best construction practices. This, in turn, means that jobs should be large enough to justify the purchasing of the best equipment by contractors and adequate inspection on the part of engineers.

It is indicated from this discussion that waterbound macadam base courses may be improved by the following construction practices:

1. A drainable sub-base laid true to grade and cross-section.
2. Use of closely sized crushed stone.
3. Lay the stone course with a self-powered stone spreader having a screed that can be operated to a string line set to grade for the layer of loose material.

Rolled Rock Base

Another type of macadam base, known as "rolled rock base," is essentially compacting into a solid mass a graded stone, including the dust of fracture. Geographically, the construction of the two types of macadam is divided by the Mississippi River, waterbound macadam base predominating on the east side and rolled rock base construction being used extensively on the west side. However, there seems to be a trend toward more widespread use of these rolled rock, crusher-run, or soil binder-aggregate base courses, as they are called in various parts of the country. The reasons for this trend will be rather apparent from the descriptions of the methods of construction which follow.

The regular practice is to scarify the old road-bed for a depth of about one foot and pulverize the loosened material. Water is added to bring the moisture content to optimum amount, and then the material is bladed and compacted to 95 per cent of

maximum density by the use of a sheeps' foot, multiple tire, or smooth faced roller.

One of the states requires that there shall be no deviation from the cross-section as shown on the plans in excess of 1/2 in. in 16 ft. However, the process of compacting by continuous blading and rolling gives a surface well within the allowable deviations, so little checking is required.


Water Is Mixed With Stone as It Is Loaded Into Trucks

The construction of rolled rock base courses, though extremely simple, must be done properly, so a job will be described which was believed to be first rate.

Of course the aggregate must conform to the grading specifications, plasticity requirements, and have a moisture content slightly above optimum before being compacted. The gradation produced, plasticity index, and the specifications were as follows:

Gradation Sieve Size	Material Produced	Specifications
	Total Passing, per cent	
2 in.		100
1 1/2 in.	100	95–100
3/4 in.	91	70–95
No. 4	53	40–65
No. 10	40	30–55
No. 40	23	16–40
No. 200	13	8–20
Plasticity Index	3	2–8

The crusher-run stone was loaded on trucks from a stockpile by a belt conveyor. However, as the stone dropped off the belt, it was discharged into a small bottomless pug mill type of mixer where water was added and mixed with the aggregate, after which it fell into the truck. An inspector weighed the trucks and upon each ticket was written the distance that the load was to cover for the particular lift being made. An inspector on the road measured off the distance at which each truck dumped its load. Thus, the state was assured that the correct quantity of aggregate was placed in the road for the designed thickness.

When sufficient material had been placed on the road to make a good working section without too great a loss in moisture, a blade grader windrowed the stone a couple of times to assure uniformity in gradation and moisture content. The windrowed stone then was spread over the road in thin layers, and each layer was compacted with a multiple tire roller until all of the aggregate had been spread. This was usually done in lifts of about 4 in. After the aggregate was spread, blading and rolling was continued until a smooth surface of the required density had been obtained. Final rolling was done by a 10 ton tandem roller.

The important control feature was the determination of density, since the only requirement was that the base course should be compacted to 100 per cent maximum density as determined by standard laboratory test.

On the job that has been described, an effort was made to obtain a gradation which would approach the average of the specifications. According to the producer, contractor, and engineer, the aggregate grading was just about right.


Compaction Is Obtained by Multiple Tire Pneumatic Roller

Since this grading seemed satisfactory from a practical point of view, let us see how it compares with a theoretical grading. A theoretical grading which has been proposed[3] for giving maximum density under field conditions based on Talbot's equation is $P = \sqrt[3]{\frac{d}{D}} \times 100$ in which P is the total per cent passing a given size sieve, d, and D is the maximum size of aggregate.

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[3] "Ballast for Highways" by F. F. Havey, before Indiana Mineral Aggregates Association, February 23, 1950

A chart has been prepared (Fig. 1) in which the ordinate is the per cent passing and the abscissa is laid off according to the scale of the cube root of the

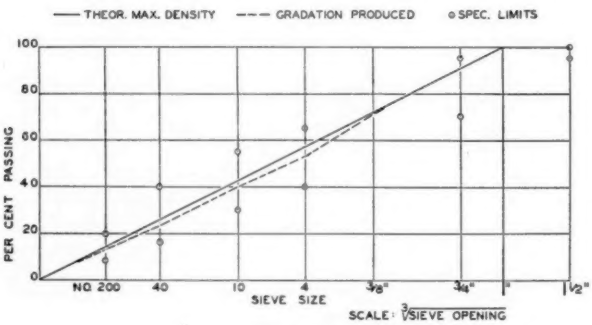

FIGURE 1

sieve opening, so that any straight line from 100 per cent which passes through the origin conforms to the equation of $P = \sqrt[3]{\frac{d}{D}} \times 100$. On this chart has been plotted the gradation as produced and the theoretical grading, as well as the specification limits.

It will be observed that the gradation which worked so well is remarkably close to the theoretical gradation and that the specifications adequately bracket this ideal. Since many members are producing a special aggregate for base construction, this gradation is suggested as being entirely satisfactory.

Stone in Windrow. Note Absence of Segregation

In the particular section of the country where this road was being built, the aggregate was considered to be a crusher-run stone. "Crusher-run" is a term that has a wide range in meaning. To many stone producers it is all the material that passes through a single crusher with one setting. To many engineers, it is a cheap grade of crushed stone. It has been demonstrated that for the best results with this type of construction, the stone must be of a continuous grading held within reasonable limits. Call it what you will, but it is not anything that will pass a given sieve.

For this particular job, the stone was produced in a semi-portable plant using a primary jaw crusher, a secondary jaw crusher, a roll crusher, and a hammer-mill—four crushers in all—and nothing was taken out. It, therefore, should be apparent that a satisfactory material is a well graded crushed stone.

Experience has shown that the best results are obtained with a well graded aggregate that binds or "sets up." Tests are made on that portion of the aggregate which passes the 40 mesh sieve to determine its plasticity index. While the plasticity index (P.I.) is a measure of the range in moisture content through which the material is plastic, it also indicates the binding properties of the material given by the aggregate in the clay size range. Since any excess of clay in a base course is particularly harmful, the plasticity index must be carefully controlled and not exceed the upper limit of 8.

Producers who are using their top strata of stone to make base course aggregate frequently find that sufficient soil adheres to give a plasticity index within the range of 2 to 8; however, they should control this characteristic of their materials, for the tests can be made readily.

It has been said that this type of construction predominates in the West, which is notably the territory of road building by contractor - producers; that is to say, aggregate production is done extensively by portable plants. Rolled rock base work lends itself admirably to portable plant operation because all of the aggregate produced is consumed by the one job. Producers with permanent plants furnishing aggregate for portland cement and bituminous concrete do not care to make a base aggregate that uses all of the high priced sizes.

Sometimes Binder-Soil Is Added to Crusher-Run Stone to Obtain a Dense, Well Blended Mix

A practical illustration of this was the case of a job which was let within five miles of the permanent plant, and it was found to be more economical to set up a portable plant near the road to produce the aggregate than to supply the stone from the fixed plant and interfere with its production schedule.

Other producers have solved the problem by making a special crusher-run aggregate with the top strata of their stone, thereby satisfying the technical requirements of gradation and plasticity index as well as that of price.

Soil-Aggregate Base


Construction Was Done a Lane at a Time in Order to Maintain Traffic

When the cost of stone is high and suitable binder soil is available at a low price, the general practice is to blend the two materials, coarse aggregate and binder soil, on the road and compact as in rolled rock base construction. High priced stone, in this instance, is considered to be stone which has a freight rate and handling charge in excess of the plant price. On one job, the stone was a true crusher-run product having 100 per cent passing the 1 1/2 in. sieve and about 15 per cent passing the No. 4 sieve. A mix that compacted to a high density was obtained by blending 30 per cent field sand which contained a binder soil of the proper characteristics.

Conclusions

An effort has been made to present a review of macadam base construction, with a statement of causes of complaints and their possible remedy, and to relate this to the production of stone. No attempt has been made to favor any one type of construction over another, for the purpose of this discussion has been to encourage first rate construction practices. The success of the flexible pavement, which is the huge potential market for crushed stone, is dependent upon the efficient building of good base courses.

Harry R. Hayes

It is with real sadness and regret that we record the death of Harry R. Hayes, Secretary and Engineering Director of the New York State Crushed Stone Association, of Albany, New York, on March 7, 1952, at 66 years of age, after a very brief illness.

Mr. Hayes, always an active and enthusiastic participant in the Conventions of the National Crushed Stone Association, had been with us in Chicago for our 35th Annual Convention during the third week in February. He did much to stimulate attendance at these meetings among the New York group, usually arranging for special cars to facilitate transportation.

Mr. Hayes was a former Utica City Engineer and Commissioner of Public Works, making many civic improvements during his terms in office. As commissioner, he discarded the old carbon arc system and installed the incandescent lighting system of Utica; installed the city's first traffic lights; inaugurated a municipally owned garbage collection system and built the city's incinerator. He supervised the first surveys of the Water Company's property; inaugurated a general sewer improvement plan and made improvements to the storm drainage system. Engineers of other cities called him for consultations on municipal sanitary engineering. He attended such conferences in New Orleans, Jacksonville, Akron, Savannah and elsewhere.

As City Engineer, he commanded attention of the State Highway Contractors' Association and he was chosen to act as its engineering director. Afterward he was made engineering director of the New York State Crushed Stone Association, with offices in Albany.

Mr. Hayes was a member of the Traffic Survey Committee and of the charter revision unit in the second-class cities division, for the State Conference of Mayors. He was organizer and first president of the State Association of City Engineers.

Deep and heartfelt sympathy is extended to his family and the members of the New York State Crushed Stone Association.

$500 Million in Federal-Aid Road Funds for Year Beginning July 1, 1952 Apportioned to the States

APPORTIONMENT of the $500 million authorized as federal aid to the states for highway construction in the fiscal year beginning July 1, 1952, has been announced by Secretary of Commerce, Charles Sawyer. The funds were authorized by the Federal-Aid Highway Act approved September 7, 1950.

The Act provides $225 million for projects on the federal-aid highway system, $150 million for projects on the federal-aid secondary system, and $125 million for projects on the federal-aid highway system in urban areas.

Funds will be expended under the supervision of the Bureau of Public Roads and according to the general procedure in use for many years in which state highway departments propose projects, prepare plans, award contracts, and supervise construction, all subject to federal approval. Federal participation is limited to half the cost except in the public-lands states where participation may be increased above 50 percent by one-half of the percentage of the area of the state that is public land. Broadly defined, a public-land state is one in which unappropriated public lands and non-taxable Indian lands exceed 5 percent of the total state area.

Funds for the federal-aid highway system are apportioned in proportion to area, population and mileage of post roads, each being given equal weight. Funds for federal-aid secondary roads are apportioned in the same manner except that rural population is used rather than total population. Funds for urban projects are apportioned in proportion to population in municipalities and other urban places of 5,000 or more. The funds apportioned will be available for expenditure until June 30, 1955.

The table given below shows apportionment by states after an allowance for administration and research has been deducted from the total authorized $500 million.

Apportionment by States of Federal-Aid Highway Funds for Fiscal Year Beginning July 1, 1952.

State	Federal-Aid Highway System ($225,000,000)	Secondary or Feeder Roads ($150,000,000)	Urban Highways ($125,000,000)	Total
Alabama	$4,667,971	$3,621,928	$1,586,037	$9,875,936
Arizona	3,294,585	2,243,550	470,881	6,009,016
Arkansas	3,659,614	2,931,245	677,225	7,268,084
California	10,160,691	5,233,338	10,761,356	26,155,385
Colorado	3,988,333	2,663,606	1,006,137	7,658,076
Connecticut	1,401,852	721,875	2,344,571	4,468,298
Delaware	1,082,813	721,875	248,278	2,052,966
Florida	3,513,455	2,295,574	2,170,778	7,979,807
Georgia	5,491,196	4,190,994	1,764,294	11,446,484
Idaho	2,737,218	1,924,535	232,987	4,894,740
Illinois	8,518,157	4,638,620	8,466,307	21,623,084
Indiana	5,248,078	3,616,889	2,896,230	11,761,197
Iowa	5,376,541	3,931,409	1,437,217	10,745,167
Kansas	5,404,541	3,781,841	1,137,837	10,324,219
Kentucky	4,062,250	3,373,828	1,257,187	8,693,265
Louisiana	3,413,927	2,472,350	1,774,598	7,660,875
Maine	1,864,396	1,333,474	505,956	3,703,826
Maryland	1,935,063	1,182,205	2,054,609	5,171,877
Massachusetts	2,783,698	1,026,797	5,038,809	8,849,304
Michigan	6,877,365	4,196,989	5,634,433	16,708,787
Minnesota	5,822,661	4,106,109	1,971,328	11,900,098
Mississippi	3,946,486	3,287,577	670,253	7,904,316
Missouri	6,369,052	4,309,461	2,981,397	13,659,910
Montana	4,475,436	3,077,359	285,067	7,837,862
Nebraska	4,294,741	3,045,380	710,025	8,050,146
Nevada	2,863,524	1,913,466	92,199	4,869,189
N. Hampshire	1,082,813	721,875	351,161	2,155,849
New Jersey	2,865,782	967,042	5,299,454	9,132,278
New Mexico	3,618,689	2,485,056	397,303	6,501,048
New York	10,383,535	4,159,385	16,181,382	30,724,302
N. Carolina	5,449,728	4,659,539	1,555,635	11,664,902
North Dakota	3,225,855	2,340,775	204,704	5,771,334
Ohio	7,696,430	4,680,567	7,005,558	19,382,555
Oklahoma	4,742,881	3,394,931	1,322,620	9,460,432
Oregon	3,798,278	2,653,463	970,723	7,422,464
Pennsylvania	8,680,399	5,165,523	9,164,833	23,010,755
Rhode Island	1,082,813	721,875	865,420	2,670,108
S. Carolina	2,985,798	2,470,183	832,764	6,288,745
South Dakota	3,452,003	2,465,050	235,135	6,152,188
Tennessee	4,711,574	3,680,474	1,750,601	10,142,649
Texas	14,305,046	9,577,321	5,799,612	29,681,979
Utah	2,540,514	1,680,413	512,969	4,733,896
Vermont	1,082,813	721,875	188,498	1,993,186
Virginia	4,204,200	3,266,315	1,887,806	9,358,321
Washington	3,666,653	2,449,109	1,826,656	7,942,418
W. Virginia	2,409,873	2,097,655	787,881	5,295,409
Wisconsin	5,254,962	3,664,818	2,370,616	11,290,396
Wyoming	2,757,134	1,868,238	131,630	4,757,002
Hawaii	1,082,813	721,875	407,089	2,211,777
Dist. of Col.	1,082,813	721,875	1,045,855	2,850,543
Puerto Rico	1,145,457	1,197,494	1,040,599	3,383,550

"Project—Adequate Roads" Organized to Stimulate Action in Solving Nation's Traffic Muddle

THE "first nationwide good roads movement in more than a quarter of a century" was launched in New York City, February 28, 1952, by executives of forty national organizations representing millions of motor vehicle owners, as well as automotive and allied industries. Represented were farm and industry groups, motor clubs, truck and bus owners, road construction industries, automotive, petroleum, and rubber industries.

These highway transportation leaders organized a Project—Adequate Roads Committee, or National PAR Committee. Stated purpose of the new organization is to arouse public action to get the nation out of the traffic muddle. The movement was compared in importance to the "Out of the Mud" campaign of the 1920's.

Arthur M. Hill, Chairman of the Executive Committee of the Greyhound Corporation and President of the National Association of Motor Bus Operators, will serve as temporary chairman of the PAR organization until its next meeting to be held in Washington, D. C., May 6, the opening day of the Fourth Highway Transportation Congress.

A temporary operating committee for PAR was created, composed of Paul B. Reinhold, President of the Atlas Equipment Corporation and President of the American Road Builders Association; L. S. Wescoat, President of the Pure Oil Company and Chairman of the Board of the American Petroleum Institute; Albert Bradley, Executive Vice President of General Motors Corporation and Chairman of the National Highway Users Conference; and ex officio, Mr. Hill.

Arthur C. Butler, Director of the National Highway Users Conference, was elected permanent secretary of the National PAR Committee.

Mr. Reinhold presented a brief statement of PAR purposes and objectives, prepared by a special committee, which was adopted. The statement emphasized proper classification of roads into systems, funds for adequate highway systems, the dedication of highway use taxes to highway purposes, fair distribution of highway costs, and improved highway administration.

Mr. Bradley said the group's first concern will be to urge defense officials to a new viewpoint of the highways' place in the nation's defense. Mr. Bradley said highway improvement is as indispensable to our defense effort as "armaments, power, or other primary elements." He said further that in many cases, defense officials seem to have taken the position that highways are "expendable" and that this attitude is reflected in meager allocations of scarce materials for essential highway improvement.

The Committee's other major concern is of a long-range character. According to spokesmen, it will be to stimulate continuing activity in highway improvement so as to "put the nation's highways on a PAR with the nation's needs."

It was emphasized that the Committee made possible a unity of effort, without placing restrictions on the individual policies or action of participating groups. He said that the functions of the committee would be: to stimulate efforts for highway improvement to meet current and continuing needs; to act as a clearing house for engineering and highway legislation information; and, in particular, to provide information to the public largely through the use of the advertising and public relations departments of participating groups.

With proper support at the state level it is believed PAR can achieve adequate roads within a reasonable time at tax rates which are warranted and fair; that PAR can coordinate the fight against diversion and dispersion of state highway user tax funds and rally support for equitable highway financing and business-like road administration; and by pin-pointing needed improvements, it is proposed to establish a priority program so that first things can be done first.

For its long-range concern of stimulating continuing road programs in all the states, the National PAR Committee will look to the Sufficiency Ratings System.

This system for highways is a scientific mechanism whereby a numerical value is applied to a specific section of road, after an engineering analysis of the highway's (1) structural condition, (2) safety features and (3) its ability to give service to the user.

Manufacturers Division—National Crushed Stone Association

These associate members are morally and financially aiding the Association in its efforts to protect and advance the interests of the crushed stone industry. Please give them favorable consideration whenever possible.

Allis-Chalmers Mfg. Co.
Milwaukee 1, Wis.
Crushing, Screening, Washing, Grinding, Cement Machinery; Motors; Texrope Drives; Centrifugal Pumps; Tractors

American Cyanamid Co.
Explosives Department
2527 Oliver Bldg., Pittsburgh 22, Pa.
Explosives and Blasting Supplies

American Manganese Steel Division American Brake Shoe Co.
109 North Wabash Ave., Chicago 2, Ill.
Manganese Steel Castings, Power Shovel Dippers, Material Handling Pumps, Heat and Corrosion Resistant Castings, Reclamation and Hard-Facing Welding Materials

American Pulverizer Co.
1249 Macklind Ave., St. Louis 10, Mo.
Manufacturers of Ring Crushers and Hammermills for Primary and Secondary Crushing

American Steel & Wire Co.
Rockefeller Bldg., 614 Superior Ave., N. W., Cleveland 13, Ohio
Wire Rope, Aerial Wire Rope Tramways, Electrical Wires and Cables, Welded Wire Fabric, Concrete Reinforcing, Wire Nails, Fencing, Netting

Atlas Powder Co.
Wilmington 99, Del.
Industrial Explosives and Blasting Supplies

Austin-Western Co.
601 N. Farnsworth Ave., Aurora 1, Ill.
Jaw and Roll Crushers, Conveyors, Feeders, Screens, and Bins—Separately or Combined in Complete Crushing, Screening and Washing Plants; All Types of Dump, Hopper, and Quarry Cars, Air and Electrically Operated, in Narrow and Standard Gauges; Power Shovels, Drag Lines, and Cranes; Road Making, Earth Handling, and Street Cleaning Equipment

Bacon-Greene & Milroy
205 Church St., New Haven 10, Conn.
"FARREL-BACON" Jaw Crushers for Primary and Secondary Operations, Conveyors, Elevators, Rolls, Screens

Bacon-Pietsch Co., Inc.
149 Broadway, New York 6, N. Y.
Manufacturers of Farrel-Bacon Crushers and Allied Screening and Conveying Equipment

Baldwin-Lima-Hamilton Corp. Lima-Hamilton Division
South Main St., Lima, Ohio
Power Shovels, Draglines and Cranes

Barber-Greene Co.
631 West Park Ave., Aurora, Ill.
Portable and Permanent Belt Conveyors, Belt Conveyor Idlers, Bucket Loaders both Wheel and Crawler Mounted, Asphalt Mixers and Finishers, Coal Handling Machines

Buchanan, C. G., Crushing Machinery Division of the Birdsboro Steel Foundry and Machine Co.
1941 Furnace St., Birdsboro, Pa.
Primary, Secondary, and Finishing Crushers and Rolls

Bucyrus-Erie Co.
South Milwaukee, Wis.
Excavating, Drilling and Material Handling Equipment

Buda Co.
154th St. and Commercial Ave., Harvey, Ill.
Diesel and Gasoline Engines; Material Handling Equipment; Lifting Jacks; Earth Drills and Maintenance of Way Equipment

Caterpillar Tractor Co.
Peoria 8, Ill.
Track-Type Tractors, Bulldozers, Earthmoving Scrapers, Motor Graders, Heavy-Duty Off-Road Hauling Units, Diesel Engines, and Diesel Electric Generating Sets

Chain Belt Co.
P. O. Box 2022, Milwaukee 1, Wis.
Rex Conveyors, Elevators, Feeders, Idlers; Drive and Conveyor Chains, Power Transmission Equipment; Concrete Mixers, Pavers, Pumpcrete and Portable Pumps

Construction Equipment
205 East 42nd St., New York 17, N. Y.
"The Equipment Application Magazine"

Continental Gin Co.
4500 Fifth Ave., S., Birmingham 2, Ala.
Conveyors—Belt, Screw, Flight, and Underground Mine; Elevators—Bucket and Screw; Feeders—Apron, Belt, Reciprocating, Table, and Screw; Drives—V-Belts, Chains and Sprockets, Gears and Speed Reducers

Cross Engineering Co.
P. O. Box 16, Carbondale, Pa.
Screen Plates and Sections, Perforated Plate for Vibrating, Rotary and Shaking Screens

Manufacturers Division—National Crushed Stone Association
(continued)

Cummins Engine Co., Inc.
Fifth and Union Sts., Columbus, Ind.
Lightweight Highspeed Diesel Engines (50-550 Hp.) for: On-Highway Trucks, Off-Highway Trucks, Buses, Tractors, Earthmovers, Shovels, Cranes, Industrial and Switcher Locomotives, Air Compressors, Logging Yarders and Loaders, Oil Well Drilling Rigs, Centrifugal Pumps, Generator Sets and Power Units, Work Boats and Pleasure Craft

Deister Machine Co.
1933 East Wayne St., Fort Wayne 4, Ind.
Deister Plat-O Vibrating Screen, Deister Compound Funnel Classifier

Detroit Diesel Engine Division General Motors Corp.
13400 West Outer Drive, Detroit 28, Mich.
Light Weight, Compact 2 Cycle Diesel Engines and "Package Power" Units for All Classes of Service

Diamond Iron Works, Inc.
1728 N. Second St., Minneapolis 11, Minn.
Jaw and Roll Crushers; Vibrator, Revolving, and Scrubber Screens; Drag Washers; Bucket Elevators; Belt Conveyors; Bins; Apron and Plate Feeders; Portable Gravel and Rock Crushing, Screening, and Washing Plants; Stationary Crushing, Screening, and Washing Plants; Hammermills

Du Pont, E. I., de Nemours & Co., Inc.
Wilmington 98, Del.
Explosives and Blasting Accessories

Eagle Iron Works
129 Holcomb Ave., Des Moines 13, Iowa
Fine Material Screw Washers—Classifiers—Dehydrators; Coarse Material Screw and Log Washers—Dewaterers; Water Scalping and Fine Material Settling Tanks; and "Swintek" Screen Chain Cutter Dredging Ladders

Easton Car & Construction Co.
Easton, Pa.
Off-Highway Transportation: Dump Trailers, Truck Bodies, and Cars for Mines, Quarries, and Earth Moving Projects

Ensign-Bickford Co.
Simsbury, Conn.
Primacord-Bickford Detonating Fuse and Safety Fuse

Euclid Road Machinery Co.
1361 Chardon Road, Cleveland 17, Ohio
Heavy-Duty Trucks and Dump Trailers for "Off-Highway" Hauls, Loaders for Earth Excavation

Even Spread Co.
P. O. Box 98, Owensville, Ohio
Power Spreaders and Attachments for Agricultural Lime and Fertilizer

Frog, Switch & Mfg. Co.
Carlisle, Pa.
Manganese Steel Department—Manufacturers of "Indian Brand" Manganese Steel Castings for Frogs, Switches, and Crossings, Jaw and Gyratory Crushers, Cement Mills, Mining Machinery, Etc., Steam Shovel Parts

General Electric Co.
1 River Road, Schenectady 5, N. Y.
Electric Motors, Controls, Locomotives, Coordinated Electric Drives for: Shovels, Drag Lines, Conveyors, Hoists, Cranes, Crushers, Screens, Etc.; Coordinated Power Generating and Distributing Systems Including Turbine Generators, Switchgear, Transformers, Cable, Cable Skids, Load Center Substations

Gill Rock Drill Co.
Lebanon, Pa.
Well Drill Tools and Supplies

Goodrich, B. F., Co.
500 South Main St., Akron 18, Ohio
Industrial Rubber Products — Flexible Bonded Edge Conveyor and Elevator Belting, Cord Conveyor Belting, Highflex and Cord Transmission Belting; Grommet V-Belts; Type 54 Air Hydraulic Control, Burst Proof Steam, Water, Suction and Other Hose; Armorite Chute Lining; Rubber and Koroseal Protective Clothing and Footwear; Tires and Tubes (Automobile, Truck, Off-the-Road, Industrial), Batteries

Goodyear Tire & Rubber Co., Inc.
Akron 16, Ohio
Airfoam; Mechanical Goods—Belting (Conveyor, Elevator, Transmission), Hose (Air Water, Steam, Suction, Miscellaneous), Chute Lining (Rubber); Rims (Truck and Tractor); Storage Batteries (Automobile, Truck, Tractor); Tires (Automobile, Truck, Off-the-Road); Tubes (Automobile, Truck, Off-the-Road, LifeGuard, Safety Tubes, Puncture Seal Tubes

Gruendler Crusher and Pulverizer Co.
2915 N. Market St., St. Louis 6, Mo.
Rock and Gravel Crushing and Screening Plants, Jaw Crushers, Roll Crushers, Hammermills, Lime Pulverizers

Gulf Oil Corp. Gulf Refining Co.
Gulf Bldg., Pittsburgh 19, Pa.
Lubricating Oils, Greases, Gasoline and Diesel Fuels

Haiss, George, Mfg. Co., Inc., Division Pettibone Mulliken Corp.
141st-144th on Park Ave., New York 51, N. Y.
Bucket Loaders, Buckets, Portable and Stationary Conveyors, Car Unloaders

Manufacturers Division—National Crushed Stone Association
(continued)

Harnischfeger Corp.
4400 W. National Ave., Milwaukee 14, Wis.
A complete line of Power Excavating Equipment, Overhead Cranes, Hoists, Smootharc Welders, Welding Rod, Motors and Generators, Diesel Engines

HarriSteel Products Co.
420 Lexington Ave., New York 17, N. Y.
Woven Wire Screen Cloth

Hayward Co.
50 Church Street, New York 7, N. Y.
Orange Peel Buckets, Clam Shell Buckets, Electric Motor Buckets, Automatic Take-up Reels

Heidenreich, E. Lee, Jr., Consulting Engineers
67 Second St., Newburgh, N. Y.
Plant Layout, Design, Supervision; Open Pit Quarry Surveys; Appraisals—Plant and Property

Hendrick Mfg. Co.
Carbondale, Pa.
Perforated Metal Screens, Perforated Plates for Vibrating, Shaking, and Revolving Screens; Elevator Buckets; Test Screens; Wedge Slot Screens; Open Steel Floor Grating

Hercules Powder Co.
Wilmington 99, Del.
Explosives and Blasting Supplies

Hetherington & Berner Inc.
701-745 Kentucky Ave., Indianapolis 7, Ind.
Asphalt Paving Machinery, Sand and Stone Dryers, Dust Collectors

Hewitt-Robins Incorporated
370 Lexington Ave., New York 17, N. Y.
Belt Conveyors (Belting and Machinery); Belt and Bucket Elevators; Car Shake-outs; Feeders; Industrial Hose; Screen Cloth; Sectional Conveyors; Skip Hoists; Stackers; Transmission Belting; Vibrating Conveyors, Feeders, and Screens; Design and Construction of Complete Plants

Illinois Powder Mfg. Co.
506 Olive St., St. Louis 1, Mo.
Gold Medal Explosives

Ingersoll-Rand Co.
11 Broadway, New York 4, N. Y.
Rock Drills, Quarrymaster Drills, Jackbits, Bit Reconditioning Equipment, Portable and Stationery Air Compressors, Air Hoists, Slusher Hoists, Air Tools, Diesel Engines, Pumps

Insley Manufacturing Corp.
801 N. Olney St., Indianapolis 6, Ind.
Concrete Carts and Buckets, ½ Yd. Cranes and Shovels

International Harvester Co.
180 N. Michigan Ave., Chicago 1, Ill.
Motor Trucks, Diesel and Gasoline Power Units; Crawler Tractors; Industrial Wheel Tractors

Iowa Manufacturing Co.
916 16th St., N.E., Cedar Rapids, Iowa
Rock and Gravel Crushing, Screening, Conveying and Washing Plants, Hot and Cold Mix Asphalt Plants, Stabilizer Plants, KU-BIT Impact Breakers, Screens, Elevators, Conveyors, Portable and Stationary Equipment, Hammermills

Jaeger Machine Co.
550 W. Spring St., Columbus 16, Ohio
Portable and Stationary Air Compressors, Self-Priming Pumps, Truck Mixers, Concrete Mixers, Road Paving Machinery, Hoists and Towers

Jaite Co.
Jaite, Ohio
Multiwall Paper Bags, Sewn and Pasted Style for Packaging Lime, Cement, Plaster, Etc.

Jeffrey Manufacturing Co.
E. First Ave., Columbus 16, Ohio
Material Handling Machinery, Crushers, Pulverizers, Screens, Chains

Johnson-March Corp.
1724 Chestnut St., Philadelphia 3, Pa.
Dust Allaying Equipment

Joy Manufacturing Co.
333 Henry W. Oliver Bldg., Pittsburgh 22, Pa.
Drills: Blast-Hole, Wagon, Rock, and Core; Air Compressors: Portable, Stationary, and Semi-Portable; Aftercoolers; Portable Blowers; Carpullers; Hoists; Multi-Purpose and Portable Rock Loaders; Air Motors; Trench Diggers; Belt Conveyors; Drill-Bit Furnaces; "Spaders"; "String-a-Lite" (Safety-Lighting-Cable); Backfill Tampers; Drill Bits: Rock and Core

Kennedy-Van Saun Mfg. & Eng. Corp.
2 Park Ave., New York 16, N. Y.
Crushing, Screening, Washing, Conveying, Elevating, Grinding, Complete Cement Plants, Complete Lime Plants, Complete Lightweight Aggregate Plants, Synchronous Motors, Air Activated Containers for Transportation of Pulverized Material, Cement Pumps, and Power Plant Equipment

Kensington Steel Co.
505 Kensington Ave., Chicago 28, Ill.
Manganese Steel Castings, Dipper Teeth, Crawler Treads, Jaw Plates, Concaves and Hammers

King Powder Co., Inc.
Cincinnati, Ohio
Detonite, Dynamites, and Blasting Supplies

Koehring Co.
3026 W. Concordia Ave., Milwaukee 16, Wis.
Excavating, Hauling and Concrete Equipment

Kraft Bag Corp.
630 Fifth Ave., New York 20, N. Y.
Heavy Duty Multiwall Paper Bags

Manufacturers Division—National Crushed Stone Association

(continued)

Le Roi Co.
Cleveland Rock Drill Division
12500 Berea Rd., Cleveland 11, Ohio
Air Compressors—Portable 60 Cfm. to 600 Cfm. Gas or Diesel; Tractairs—Combined Tractor with 105 Cfm. Air Compressor; Engines; Generator Sets; Rock and Wagon Drills; Jumbo Drill Rigs, Drifters, Stopers, Self Propelled Drill Rigs

Link-Belt Co.
300 West Pershing Road, Chicago 9, Ill.
Complete Stone Preparation Plants; Conveyors, Elevators, Screens, Washing Equipment, Speed-O-Matic Shovels—Cranes—Draglines and Power Transmission Equipment

Ludlow-Saylor Wire Co.
634 S. Newstead Ave., St. Louis 10, Mo.
Woven Wire Screens and Wire Cloth of Super-Loy, All Commercial Alloys and Metals

Mack Manufacturing Corp.
350 Fifth Ave., New York 1, N. Y.
On- and Off-Highway Trucks, Tractor Trailers, Six-Wheelers, from 5 to 30 Tons Capacity, both Gasoline- and Diesel-Powered

Marion Power Shovel Co.
617 W. Center St., Marion, Ohio
A Complete Line of Power Shovels, Draglines, and Cranes

Marsh, E. F., Engineering Co.
4324 W. Clayton Ave., St. Louis 10, Mo.
Plant Design, Engineering Service, Complete Pit and Quarry Equipment

McLanahan & Stone Corp.
200 Wall St., Hollidaysburg, Pa.
Complete Pit, Mine, and Quarry Equipment —Crushers, Washers, Screens, Feeders, etc.

Michigan Power Shovel Co.
270 Miller St., Benton Harbor, Mich.
Truck Mounted and Crawler Shovel Crane 3/8 and 1/2 Cu. Yd.

Murphy Diesel Co.
5317 W. Burnham St., Milwaukee 14, Wis.
Murphy Diesel Engines Ranging from 90 to 190 Continuous Horsepower at 1200 Rpm. and Packaged Type Generator Sets 60 to 133 Kw. for All Classes of Service

National Amalga-Pave, Inc.
357 S. Robertson Blvd., Beverly Hills, Calif.
Amalga-Pave Cold Mix Asphalt Paving Process

New York Rubber Corp.
100 Park Ave., New York 17, N. Y.
Conveyor Belting: Stonore, Dependable, and Cameo Grades; Transmission Belting: Silver Duck Duroflex, Soft Duck Rugged, Commercial Grade Tractor

Nordberg Mfg. Co.
3073 S. Chase Ave., Milwaukee 7, Wis.
Cone, Gyratory, Jaw and Impact Crushers; Grinding Mills; Stone Plant and Cement Mill Machinery; Vibrating Screens; Grizzlies; Diesel and Steam Engines; Compressors; Mine Hoists; Track Maintenance Tools

Northern Blower Co.
6409 Barberton Ave., Cleveland 2, Ohio
Dust Collecting Systems, Fans—Exhaust and Blower

Northwest Engineering Co.
135 S. LaSalle St., Chicago 3, Ill.
Shovels, Cranes, Draglines, Pullshovels

Olin Industries, Inc.
Explosives Division
East Alton, Ill.
Dynamite, Black Powder, Blasting Caps, Blasting Supplies

Osgood Co.
Cheney Ave., Marion, Ohio
Power Shovels, Cranes, Draglines, Hoes, Etc., 3/8 to 2 1/2 Cu. Yd.

Pennsylvania Crusher Co.
Liberty Trust Bldg., Broad and Arch Sts., Philadelphia 7, Pa.
Single Roll Crushers, Impactors, Hammermills, Ring Type Granulators, KUE-KEN Jaw Crushers, KUE-KEN Gyracones, Dixie Non-Clog and Standard Hammermills

Pettibone Mulliken Corp.
4710 W. Division St., Chicago 51, Ill.
Buckets, Dragline and Parts; Loaders—Car, Bucket; Plants—Asphalt, Portable

Pioneer Engineering Works, Inc.
1515 Central Ave., N. E., Minneapolis 13, Minn.
Jaw Crushers, Roll Crushers (Twin and Triple), Vibrating and Revolving Screens, Feeders (Mechanical, Grizzly, Apron, and Pioneer-Oro), Belt Conveyors, Portable and Stationary Crushing and Screening Plants, Washing Plants, Mining Equipment, Cement and Lime Equipment, Asphalt Plants

Pit and Quarry Publications
431 S. Dearborn St., Chicago 5, Ill.
Pit and Quarry, Pit and Quarry Handbook, Pit and Quarry Directory, Concrete Manufacturer, Concrete Industries Yearbook

Quaker Rubber Corp.
Tacony and Milnor Sts., Philadelphia 24, Pa.
Conveyor Belts, Hose, and Packings

Rock Bit Sales and Service Co.
350 Depot St., Asheville, N. C.
Tungsten Carbide Detachable Bits, "Rock Bit" Drill Steel Inlaid with Tungsten Carbide, Carbon Hollow Drill Steel, Alloy Hollow Drill Steel

Manufacturers Division—National Crushed Stone Association
(concluded)

Rock Products
309 West Jackson Blvd., Chicago 6, Ill.

Roebling's, John A., Sons Co.
Woven Wire Fabrics Division
P. O. Box D, Roebling, N. J.
Aggregate Screen, Hardware and Industrial Wire Cloth, Insect Screening, Wire Rope, Fittings and Strand, Slings, Suspension Bridges and Cables, Aerial Wire Rope Systems, Ski Lifts, Electric Wire and Cable, Magnet Wire

Sanderson-Cyclone Drill Co.
South Main St., Orrville, Ohio
All Steel Wire Line, Air Speed Spudders, Large Blast Hole Drills, Drilling Tools and Drilling Supplies

Schield Bantam Co.
Waverly, Iowa
Bantam Trench Hoes, Draglines, Clams, Shovels

Screen Equipment Co.
1754 Walden Ave., Buffalo 25, N. Y.
SECO Vibrating Screens

Shaped Charge Explosive Manufacturers, Inc.
P. O. Box 900, Martinsburg, W. Va.
Shaped Charge Explosives for Industrial Rock Reduction

Simplicity Engineering Co.
Durand, Mich.
Simplicity Gyrating Screen, Simplicity D'centegrator, Simplicity D'watering Wheel

SKF Industries, Inc.
Front St. and Erie Ave., P. O. Box 6731, Philadelphia 32, Pa.
Anti-Friction Bearings—Self-Aligning Ball, Single Row Deep Groove Ball, Angular Contact Ball, Double Row Deep Groove Ball, Spherical Roller, Cylindrical Roller, Ball Thrust, Spherical Roller Thrust; Pillow Block and Flanged Housings—Ball and Roller

Smith Engineering Works
532 E. Capitol Drive, Milwaukee 12, Wis.
Gyratory, Gyrasphere, Jaw and Roll Crushers, Vibrating and Rotary Screens, Gravel Washing and Sand Settling Equipment, Elevators and Conveyors, Feeders, Bin Gates, and Portable Crushing and Screening Plants

Stedman Foundry & Machine Co., Inc.
Aurora, Ind.
Stedman Impact-Type Selective Reduction Crushers, 2-Stage Swing Hammer Limestone Pulverizers

Stephens-Adamson Mfg. Co.
Aurora, Ill.
Belt Conveyors, Elevators, Feeders, Car Pullers, Screens, Skip Hoists, Complete Plants

Talcott, W. O. & M. W., Inc.
91 Sabin St., Providence 1, R. I.
Belt Fasteners, Belt Lacing, Conveyor Belt Fasteners, and Patch Fasteners

Taylor-Wharton Iron & Steel Co.
High Bridge, N. J.
Manganese and other Special Alloy Steel Castings; Dipper Teeth, Fronts and Lips; Crawler Treads; Jaw and Cheek Plates; Mantles and Concaves; Pulverizer Hammers and Liners; Asphalt Mixer Liners and Tips; Manganese Nickel Steel Welding Rod and Plate

Thew Shovel Co.
East 28th St. and Fulton Rd., Lorain, Ohio
Power Shovels, Cranes, Crawler Cranes, Locomotive Cranes, Draglines, Diesel Electric, Gasoline, 3/8 to 2 1/2 Cu. Yd. Capacities

Torrington Co.
Bantam Bearings Division
3702 W. Sample St., South Bend 21, Ind.
Anti-Friction Bearings; Roller Bearings: Spherical, Tapered, Straight, Ball, Needle

Traylor Engineering & Mfg. Co.
Allentown, Pa.
Stone Crushing, Gravel, Lime, and Cement Machinery

Trojan Powder Co.
17 N. 7th St., Allentown, Pa.
Explosives and Blasting Supplies

Tyler, W. S., Co.
3615 Superior Ave., N. E., Cleveland 14, Ohio
Woven Wire Screens; Ty-Rock, Tyler-Niagara and Ty-Rocket (Mechanically Vibrated) Screens; Hum-mer Electric Screens; Ro-Tap Testing Sieve Shakers and Tyler Standard Screen Scale Sieves

Universal Engineering Corp.
625 C Ave., N. W., Cedar Rapids, Iowa.
Jaw Crushers, Roll Crushers, Hammermills, Complete Crushing, Screening, and Loading Plants, Either Stationary or Portable for Stone Aggregates or Aglime

Vibration Measurement Engineers
7665 Sheridan Rd., Chicago 26, Ill.
Specialists in Blasting Complaint Investigations; Seismological Surveying; Expert Testimony in Blasting Litigation

Werco Steel Co.
2151 E. 83rd St., Chicago 17, Ill.
Crusher Jaws, Roll Shells, Mantles, Bowl Liners, Conveyor and Elevator Chain, All Types Wear Resistant Steel Manganese and Alloy Steel Castings

Weston Dump Body Co.
326 S. W. 11th St., Des Moines, Iowa
Combination Lime, Sand, and Gravel Body; Special Bodies for Quarry and Pit Work

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842 E. 79th St., Cleveland 1, Ohio
On- and Off-Highway Trucks and Tractors—Gasoline- and Diesel-Powered; Industrial Engines, Power Units, Axles, Special Machine Assemblies; All Classes of Service

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National Crushed Stone Association

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No. 1. How to Proportion Workable Concrete for Any Desired Compressive Strength

No. 2. How to Proportion Concrete for Pavements

No. 3. Uses for Stone Screenings

No. 4. How to Determine the Required Thickness of the Non-Rigid Type of Pavement for Highways and Airport Runways

No. 5. The Insulation Base Course Under Portland Cement Concrete Pavements

ENGINEERING BULLETINS

No. 1. The Bulking of Sand and Its Effect on Concrete

No. 2. Low Cost Improvement of Earth Roads with Crushed Stone

No. 3. The Water-Ratio Specification for Concrete and Its Limitations (Supply Exhausted)

No. 4. "Retreading" Our Highways

No. 5. Reprint of "Comparative Tests of Crushed Stone and Gravel Concrete in New Jersey" with Discussion

No. 6. The Bituminous Macadam Pavement

No. 7. Investigations in the Proportioning of Concrete for Highways

No. 8. The Effect of Transportation Methods and Costs on the Crushed Stone, Sand and Gravel, and Slag Industries (Supply Exhausted)

No. 9. Tests for the Traffic Durability of Bituminous Pavements

No. 10. Stone Sand (Supply Exhausted)

No. 11. A Method of Proportioning Concrete for Strength, Workability, and Durability. (Revised January, 1949)

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Single copies of the above publications are available upon request.

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